PLANT AND SOIL SCIENCE

5170

CIP Code: 02.0401

Plant and Soil Science is a year long course that provides students with opportunities to participate in a variety of activities including laboratory work. Topics covered include: the taxonomy of plants, the various plant components and their functions, plant growth, plant reproduction and propagation, photosynthesis and respiration, environmental factors affecting plant growth, diseases and pests of plants and their management, biotechnology, the basic components and types of soil, calculation of fertilizer application rates and procedures for application, soil tillage and conservation, irrigation and drainage, land measurement, cropping systems, precision agriculture, principles and benefits of global positioning systems, harvesting, and career opportunities in the field of plant and soil science.

- Suggested Grade Levels: 10-12
- Recommended Prerequisite: Fundamentals of Agricultural Science and Business or by permission of the teacher
- A two credit/two semester course.
- This course may fulfill up to two credits of the minimum science requirement for graduation.
- A Core 40 directed elective as part of a technical career area.
- This course qualifies as an Academic Honors Diploma elective.
- Competencies and learning activities defined.
- This course is included as a component of the Agriculture and Natural Resources career cluster and may also be included as a component of the Engineering, Science, and Technologies career cluster.

Plant and Soil Science

A. Students shall examine career opportunities in and the importance of plant and soil science.

1. Describe the interrelationship of careers in plant and soil science and the environment as a whole.
2. Explain the economic importance of plant and soil science in local, state, regional (corn belt), national and global communities.
3. Refine previously developed mental models about career opportunities, educational and job requirements, and career trends i.e., biotechnology, based upon newly acquired information.

B-1. Students shall use the basic principles of the taxonomic key.

1. Analyze the "system of classification" developed by Carolus Linnaeous for clarity and specificity.
2. Explain the taxonomy and describe its use in the study of plants.
3. Order the following terms of plant classification: kingdom, division, class, order, family, genus, species and variety, and generate a different (unique) classification system for plants.
4. Contrast botanical varieties with cultivars and give six examples of each from both decorative and agricultural plants.
5. Propose reasons for the current use of the modern system of plant classification.
6. Explain the origin of a scientific plant name and describe the significance of the first and second word of the name.

B-2. Students shall use plant characteristics in a taxonomic key.

1. Describe criteria for distinguishing characteristics of the plant kingdom from the animal, fungi, protist and monera kingdoms.
2. Justify the three bases on which agriculture plants can be classified using newly developed criteria.
3. Classify plants according to their five major parts.
4. Sketch, name, and provide three examples of each of the four types of leaf arrangements on a stem.
5. Describe the implications for cultivating plants based upon their classification by growth habits.
6. Contrast the structures and germination process of monocotyledons and dicotyledons and explain the leaf and flower structures of each as they grow.

7. Identify by visual inspection and assign scientific names to the common crop and weed plants and seeds.
8. Distinguish between noxious and semi-noxious weeds and explain the cultural ramifications of each.
9. Develop a plan for improving plant species based on their characteristics (e.g. leaves, seeds, roots).

C-1. Students shall explore plant cell parts and functions.

1. Sketch a plant cell, identify its parts (e.g., cytoplasm, vacuole, chloroplast, mitochondria, nucleus and cell wall), and explain the function of each.
2. Compare the processes of mitosis and meiosis in plants, describe the purpose and products, and give examples of where each occurs.
3. Sketch a plant and animal cell, comparing and contrasting the two. Then develop a rationale for the purposes of the primary differences.
4. Identify and contrast the sequence of events in the mitosis of plant and animal cells.
5. Relate meiosis to: a) the prediction of variation of characteristics in off-spring, and b) Mendel's laws of segregation and independent assortment.

C-2. Students shall explore plant parts and their functions.

1. Compare the four primary plant structures, indicating the functions and food value of each. Discuss how planting decisions in underdeveloped countries could be based on this information.
2. Explain the importance of meristematic tissue in growth and physiology, and in relationship to plant reproduction.
3. Compare and contrast specialized roots, stems, and leaves (e.g., stolons, rhizomes, bulbs, tubers). Sketch and label appropriate examples of each type.
4. Predict the adaptations that may be initiated in various plants that survive a changing environment.
5. Describe how these structures contribute to the well being of the total plant: a) roots—corn plant, b) transport—woody plant, c) xylem—roots, stems, leaves.
6. Discuss how an individual could use knowledge of plant structures to grow a bountiful harvest of vegetables in a given location.

D. Students shall investigate material movements in plants.

1. Diagram the transpirational and translocational systems of a plant and describe the functions of each (e.g., cambium, xylem, phloem).
2. Explain why knowledge of the translocational system of plants is necessary for successful grafting.

3. Compare transpiration through the stomata and the pores of human skin and explain the role of water in each.
4. Discuss how the four environmental factors of wind, humidity, temperature, and insolation affect transpiration rates of plants.
5. Describe the process of transportation to and the resulting change in target structures for two plant hormones.
6. Relate translocation of water and plant nutrients to the process of photosynthesis.

E. Students shall explore the environmental factors affecting plant growth.

1. Analyze growth of a plant from a seed or cutting to marketable or harvestable size and examine the effects of plant maintenance on the plant.
2. Discuss the environmental factors affecting plant growth and formulate a plan to best use a plot of ground for a personal vegetable garden.
3. Discuss the effects of photoperiodism in plant growth and the possible economic uses of this scientific knowledge to benefit society.
4. Given data from suitable observations of plant growth at various temperatures, plot the data and generalize from its analysis the optimum temperature range for the growth of that plant.
5. Develop an experiment that will show how a plant may adapt to environmental changes such as change in direction of light source, change in position, or gravity.

F. Students shall analyze the germination of plants.

1. Discuss the requirements necessary for seed germination and analyze factors that might decrease germination rates.
2. Compare the life-cycle of a dicotyledonous plant and a monocotyledonous plant from seed to seed production. Address how their differences require varied approaches to planting and cultivation techniques.
3. Discuss the impact upon society of at least five major products which are seed by-products.
4. Based upon knowledge of seed germination factors, develop a plan to increase wheat crop production in the former Soviet Union in light of their past environmental history.

G-1. Students shall investigate plant reproduction.

1. Describe the various processes by which asexual reproduction may occur and cite examples to illustrate: a) fission, b) budding, c) regeneration, d) layering, e) fragmentation, f) sporulation.
2. Develop a set of criteria and determine the most advantageous of the four methods by which pollen is distributed.

3. Analyze the major events that take place in plant reproduction including pollination, fertilization and seed production.
4. Compare and contrast advantages and disadvantages of seed production (sexual) with vegetative propagation (asexual).
5. Devise and conduct an experiment with garden peas similar to that of Gregor Mendel. Predict and verify results.
6. Construct a model to demonstrate four environmental factors that affect the rooting of a stem cutting.
7. Cite examples of plants that propagate by each of the ten asexual methods and describe the agricultural impact of each in terms of cost, space needed, and ease of generation.
8. Explain how heredity and environment affect offspring in plants.

G-2. Students shall explore energy synthesis and use in plants.

1. Compare and contrast the processes of photosynthesis and respiration using both word and chemical equation format.
2. Discuss how energy is acquired and released in the photosynthetic process.
3. Describe the carbon-oxygen-hydrogen cycle as it occurs in the biosphere by relating the role of the various component materials and processes such as: a) the series of events in photosynthesis which lead to capturing energy, b) green plants, c) animals, d) the series of events in respiration that release energy from food, and e) conservation of energy in the cycle.
4. Analyze the process by which simple sugars are transformed into complex organic compounds (starch, fats, etc.) Compare this with the opposite process in animals.
5. Explain the role of the chlorophyll molecule in photosynthesis.
6. Discuss the external environmental factors which influence photosynthesis. How does environmental pollution effect our future survival with regard to plant (crop) production?
7. Describe the role of enzymes in the total process of photosynthesis.

H. Students shall analyze the impact of other life forms on crop plants.

1. Describe how "pests" play a role in crop quality.
2. Cite common plant diseases in your area and discuss possible ways they are transmitted and eradicated.
3. Analyze the relationship of proper plant nutrition with improved plant health in the areas of development, growth, and production of plants.
4. Discuss "integrated pest management" and describe ways to implement this into a management program. Predict difficulties which might be encountered during implementation with respect to current environmental protection regulations.

5. Prepare a sample pest management plan using mechanical, biological, and chemical control of plant pests for a school garden. Cite advantages and disadvantages of both.
6. Describe a biome in which plants and both beneficial and harmful insects exist. Analyze why some insects are helpful and detail the harm done by others.
7. Discuss the life cycles of the grasshopper and mite and explain why insects which go through a compete metamorphosis are the most damaging to plants.
8. Describe the differences in agricultural techniques worldwide as a result of the variety of nematodes and their specific damage patterns.
9. Discuss the ways that weeds cause damage and production loss.
10. For the weeds common to your area, identify means of weed control other than chemicals.
11. Analyze the uses for both a contact and systemic pesticide and predict the types and quality of foods available if a pesticide free society is declared.
12. Compare the effects of selective and nonselective herbicide and how they might be used for sterilization, clean-up, and weed control.
13. Discuss the three plant growth periods when herbicides can be applied and advantages of each.
14. Discuss the four categories of pesticides and evaluate a proposal to ban highly toxic pesticides in terms of the quality of life that would be produced.

I. Students shall explore the processes involved in biotechnology in plant science.

1. Discuss how biotechnology will influence agriculture in the future.
2. Relate the scientific method to the basic processes of biotechnology research.
3. Determine the scientific and technological knowledge and skills needed for career opportunities in biotechnology.
4. Describe at least three developments or applications resulting from biotechnology research in plant and soil science specifically related to disease resistance, product quality and photosynthesis.
5. Predict future impacts of microorganism research.
6. Relate how genetic engineering can affect one's future health and well-being.
7. Debate the positive and negative effects of one type of biotechnical research; address environmental and ethical concerns, concerns over control of the research, and concerns over conflict of interest.

J. Students shall investigate the various methods of land location and measurement using all appropriate technologies.

1. Generate an accurate sketch of all townships in their school district using section numbers, map symbols, and appropriate hard copy and computer technologies.

2. Appraise and utilize the index to owners to find a specific farm or land parcel. Describe how computer technology could be used to streamline land record keeping.
3. From the table of land measurements, calculate acreage from each type of measurement.
4. Identify and measure farms and fields from aerial photographs, taking into consideration topographic crests, the elevation of flight and lens angle.
5. Compose an accurate land description of a land parcel and measure the parcel to the nearest 1/100th acre.
6. Identify and sketch a land parcel from its description.

K. Students shall investigate the physical properties of the soil.

1. Considering the major factors in the formation of soils, describe the probable past of the soil found on the school grounds.
2. Construct a model to explain why soil of different ages is exposed in Indiana and surrounding states.
3. Give examples of how humans are dependent upon soil, directly or indirectly, for their food, clothing and shelter.
4. Evaluate the quality of a parcel of land based upon the horizons in a soil profile.
5. Describe how the basic components of a soil influence its possible uses.
6. Using information about the soil textural classes, describe how the soil provides for the growing of plants.
7. Describe the perfect physical traits of soil for a garden in terms of color and texture.
8. From observations of simple experiments, identify and briefly explain mechanisms by which minerals are changed in the formation of soil.
9. Explain the action of rivers, wind, and glaciers in the deposition of parent material in Indiana soils.

L. Students shall investigate the tillage practices necessary to keep soil productive.

1. Relate the several factors that contribute to soil compaction and the destruction of soil tilth to a discussion of the advantages and disadvantages of cultivation.
2. Describe the visible effects of soil compaction on plants and the effects it has on soil.
3. Evaluate the various methods of land preparation and seeding based on soil and plant characteristics.
4. Use the TESTOP computer program to determine the optimum tillage system for a specific 160 acre farm.

5. Explain the effect of depth of planting on seed emergence and relate plant germination characteristics to soil properties.
6. Discuss the advantages and disadvantages of incorporating crop residues or green manures into the soil.

M. Students shall explore the management strategies required to keep soil productive.

1. Relate the nitrogen cycle to the question of fertilizer choice.
2. Discuss the benefits of earthworms and micro-organisms in the soil
3. Describe types of organic matter in the soil and analyze ways to benefit the soil.
4. Distinguish among an acid, alkaline, and saline soil condition and describe their effects on plant growth.
5. Analyze soil environmental factors affecting plant nutrient availability and suggest ways to improve the effect of each.
6. Cite examples of how humans have affected nature and predict some consequence if they continues on their present course.
7. Analyze the effect of cation exchange capacity on soil pH and fertility.
8. Calculate the content of N-P-K in a fertilizer container from information on the package and calculate the amount of nitrogen needed for an acre of a crop using a selected nitrogen source.
9. Given a group of unhealthy plants, identify symptom and plant nutrient deficiencies when the following minerals are inadequate: N, P, K, Fe, S, Mg. Devise and conduct an experiment to use noncommercial remedies for the problem.
10. Compare advantages and disadvantages of organic and inorganic fertilizer in a world becoming more conscience of environmental pollution.
11. Describe general methods for testing soil deficiency. Identify a source for each of the three primary elements.
12. Perform a soil test and complete a report on the test. Compare this to a commercial soil test report and determine the proper amounts of N, P and K to put on a field.
13. Discuss the affect of high and low soil pH on the availability of plant nutrients and describe ways to increase or lower pH using soil amendments.

N. Students shall examine soil and water relationships.

1. Differentiate between infiltration and percolation and describe their effect on water availability.
2. Discuss how water in soil can move upward against gravitational pull and cite examples of this action in various soil types.
3. Discuss hydroponics and explain why it might be the wave of the future.

4. Given a specific land description, formulate a plan to modify soil to improve moisture relationships. Consider cost, feasibility, and environmental impact.
5. Discuss how the normal hydrologic cycle of the earth has been disrupted by volcanic eruption, the ozone layer demise and other negative environmental effects.
6. Evaluate the different types of irrigation systems based upon various crop and soil conditions.
7. Given the appropriate information, calculate the approximate amount of water needed and the cost for that water for a single complete production cycle for a major local crop.
8. Construct a demonstration showing possible methods that would help to control the runoff of a give watershed.
9. Address the problem of chemical impurities in agricultural waste water run-off in the form of a speech to a civic organization.
10. Describe the effects of soil texture on depth of water penetration and water and nutrient holding capacity.

O. Students shall investigate the soil conservation practices necessary to keep soil productive.

1. Propose management practices and cropping systems when given features and land capabilities that would help improve the usefulness of the land.
2. Describe how the types of information found within a soil survey assist in soil conservation.
3. Read and interpret a soil classification map using the USDA Land Use Capability Classification system as if interested in purchasing farm land.
4. Discuss the advantages/disadvantages of organic and inorganic soil amendments. Cite situations where both types would be useful in improving the soil.
5. Explain how roots interact with soil and relate this to the process of nitrogen fixation.
6. Relate the factors that influence soil water erosion to the detrimental effects that can be minimized with specific conservation practices.
7. Analyze affects of wind erosion and evaluate several management procedures such as windbreaks.
8. Explain how the programs and services provided by the soil conservation service contribute to successful soil management in Indiana.
9. Calculate soil loss using the universal soil loss equation.
10. Measure slope and explain the relationship between steepness of slope and erosion.

P. Students shall analyze the impact of several factors on the selection of a cropping system and cultural practices.

1. Explain why the most profitable crops aren't grown on all available land.
2. Describe the factors that must be considered when selecting a crop.
3. Develop an argument both for and against crop rotation.
4. Describe the relationship between cropping intensity and income.
5. Analyze how conservation is affected by cropping systems and cultural practices. Identify and evaluate two specific cropping systems used in Indiana.

Q. Students shall investigate the harvesting of crops in Indiana.

1. Relate the history of the development of three specialized types of harvesting equipment used in Indiana to the crop each is used to harvest.
2. Discuss the relationship of planting technique with harvesting loss in corn. Determine the optimum economic procedure.
3. Explain characteristics that determine harvest maturity for corn and soybeans.
4. Discuss the economic impact of delayed harvesting of crops in the fall.
5. Describe problems involved with the storage and transportation of major Indiana crops. Address how these relate to the placement of towns, rivers, and railroads historically.